CLAIMS

What is claimed is:

1. A speaker-characteristic compensation method for a mobile terminal device having at least two speakers in a case, the method comprising, for input signals to the speakers, a process of reducing crosstalk that, within the case, occurs between the speakers.

2. The speaker-characteristic compensation method according to claim 1, wherein the process includes a step of adding to an input signal to the other speaker a reduction signal for reducing a sound that, within the case, leaks from the one speaker into the other speaker.

3. The speaker-characteristic compensation method according to claim 2, wherein the reduction signal is created through processing of an input signal to the one speaker.

4. The speaker-characteristic compensation method according to claim 3, wherein an input signal to the one speaker is processed based on a characteristic obtained by dividing a transfer characteristic, through which a driving signal for driving the one speaker is transformed by at least acoustic coupling and emitted from the other speaker, by a transfer characteristic, through which a driving signal for driving the other speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the other speaker, and by reversing the sign of said characteristic.

5. The speaker-characteristic compensation method apparatus according to claim 1, the process comprising:

a first direct processing step of processing an input signal to be a direct component to the other speaker;

a first cross processing step of processing an input signal to the one speaker, thereby obtaining a cross component to the other speaker;

a first addition step of adding respective signals obtained through the first direct processing step and the first cross processing step, thereby creating a driving signal for driving the other speaker;

a second direct processing step of processing an input signal to be a direct component to the one speaker;

a second cross processing step of processing an input signal to the other speaker, thereby obtaining a cross component to the one speaker; and

a second addition step of adding respective signals obtained through the second direct processing step and the second cross processing step, thereby creating a driving signal for driving the one speaker;

6. The speaker-characteristic compensation method according to claim 5, wherein the first direct processing step is based on a transfer characteristic through which a driving signal for driving the one speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the one speaker, the first cross processing step is based on a transfer characteristic through which a driving signal for driving the one speaker is transformed by at least acoustic coupling and emitted from the other speaker, the second direct processing step is based on a transfer characteristic through

which a driving signal for driving the other speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the other speaker, and the second cross processing step is based on a transfer characteristic through which a driving signal for driving the other speaker is transformed by at least acoustic coupling and emitted from the one speaker.

7. The speaker-characteristic compensation method according to claim 5, comprising a post-processing step of further processing a signal, to the other speaker, that has been obtained through addition in the first addition step, in order that a speaker emission signal emitted from the other speaker coincides in amplitude or phase with an input signal to the other speaker.

8. The speaker-characteristic compensation method according to claim 5, comprising a pre-processing step of, prior to the first direct processing step and the first cross processing step, processing an input signal to the other speaker so that a speaker emission signal emitted from the other speaker coincides in amplitude or phase with the input signal to the other speaker.

9. The speaker-characteristic compensation method according to any one of claims 3 and 4, wherein an input signal to the one speaker is processed per subband of the input signal to the one speaker.

10. The speaker-characteristic compensation method according to claim 4, wherein an input signal to the one speaker is processed based on a characteristic obtained by adding a low-pass filter to said characteristic.

11. The speaker-characteristic compensation method according to any one of claims 3 and 4, wherein an input signal to the one speaker is processed in accordance with the correlation between the input signal to the one speaker and an input signal to the other speaker, the correlation being obtained per frequency component.

12. The speaker-characteristic compensation method according to claim 3, wherein an input signal to the one speaker is processed based on a characteristic obtained by multiplying by a scalar value of smaller than one the input signal to the one speaker and reversing the sign of the resultant signal.

13. The speaker-characteristic compensation method according to claim 5, wherein the direct processing steps for the other and the one speaker or the cross processing steps for the other and the one speaker are approximately equivalent.

14. A mobile terminal device having at least two speakers in a case, comprising, for input signals to the speakers, a processing means for reducing crosstalk that, within the case, occurs between the speakers.

15. The mobile terminal device according to claim 14, wherein the processing means adds a reduction signal for reducing a sound that, within the case, leaks from the one speaker into the other speaker to an input signal to the other speaker.

16. The mobile terminal device according to claim 15, wherein the reduction signal is created through processing of an input signal to the one speaker.

17. The mobile terminal device according to claim 16, wherein an input signal to the one speaker is processed based on a characteristic obtained by dividing a transfer characteristic, through which a driving signal for driving the one speaker is transformed by at least acoustic coupling and emitted from the other speaker, by a transfer characteristic, through which a driving signal for driving the other speaker is transformed by at least an amplifier characteristic and a speaker characteristic and emitted from the other speaker, and by reversing the sign of said characteristic.

18. The mobile terminal device according to claim 14, the processing means comprises:

a first direct processing means for processing an input signal to be a direct component to the other speaker;

a first cross processing means for processing an input signal to the one speaker, thereby obtaining a cross component to the other speaker;

a first addition means for adding respective signals obtained through the first direct processing and the first cross processing, thereby creating a driving signal for driving the other speaker;

a second direct processing means for processing an input signal to be a direct component to the one speaker;

a second cross processing means for processing an input signal to the

other speaker, thereby obtaining a cross component to the one speaker; and

a second addition means for adding respective signals obtained through the second direct processing and the second cross processing, thereby creating a driving signal for driving the one speaker;

19. The mobile terminal device according to claim 18, wherein the first direct processing means is based on a transfer characteristic through which a driving signal for driving the one speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the one speaker, the first cross processing means is based on a transfer characteristic through which a driving signal for driving the one speaker is transformed by at least acoustic coupling and emitted from the other speaker, wherein the second direct processing means is based on a transfer characteristic through which a driving signal for driving the other speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the other speaker, and the second cross processing means is based on a transfer characteristic through which a driving signal for driving the other speaker is transformed by at least acoustic coupling and emitted from the one speaker.

20. The mobile terminal device according to claim 18, comprising a post-processing means for further processing a signal, to the other speaker, which has been obtained through addition by the first addition means, in order that a speaker emission signal emitted from the other speaker coincides in amplitude or phase with an input signal to the other speaker.

21. The mobile terminal device according to claim 18, comprising a pre-processing means for, prior to the first direct processing and the first cross processing, processing an input signal to the other speaker so that a speaker emission signal emitted from the other speaker coincides in amplitude or phase with the input signal to the other speaker.

22. The mobile terminal device according to any one of claims 16 and 17, wherein an input signal to the one speaker is processed per subband of the input signal to the one speaker.

23. The mobile terminal device according to claim 17, wherein an input signal to the one speaker is processed based on a characteristic obtained by adding a low-pass filter to said characteristic.

24. The mobile terminal device according to any one of claims 16 and 17, wherein an input signal to the one speaker is processed in accordance with the correlation between the input signal to the one speaker and an input signal to the other speaker, the correlation being obtained per frequency component.

25. The mobile terminal device according to claim 16, wherein an input signal to the one speaker is processed based on a characteristic obtained by multiplying by a scalar value of smaller than one the input signal to the one speaker and reversing the sign of the resultant signal.

26. The mobile terminal device according to claim 18, wherein the direct

processing means for the other and the one speaker or the cross processing means for the other and the one speaker are approximately equivalent.

27. A speaker-characteristic compensation method, for a mobile terminal device having N speakers contained in a case, in which a speaker emission signal Si emitted from i-th speaker is given by Equation 31, by means of a matrix H including a transfer characteristic Hij through which a driving signal Sdi for driving the i-th speaker is transformed by at least inner-case acoustic coupling and emitted from j-th speaker, and a transfer characteristic Hii through which a driving signal Sdi for driving the i-th speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the i-th speaker,

$$\begin{bmatrix} S_1 \\ S_2 \\ \cdots \\ S_N \end{bmatrix} = \mathbf{HSd} = \begin{bmatrix} H_{11}, H_{21}, \cdots, H_{N1} \\ H_{12}, H_{22}, \cdots, H_{N2} \\ \cdots \\ H_{1N}, H_{2N}, \cdots, H_{NN} \end{bmatrix} \begin{bmatrix} Sd_1 \\ Sd_2 \\ \cdots \\ Sd_N \end{bmatrix} \quad (31)$$

wherein the driving signal Sdi for the i-th speaker is created by processing an input signal Xi for the i-th speaker with a filter characteristic G, given by Equation 32, that is based on a cofactor Qij of an (i, j) component of the matrix H.

$$\begin{bmatrix} Sd_1 \\ Sd_2 \\ \cdots \\ Sd_N \end{bmatrix} = \mathbf{G} \begin{bmatrix} X_1 \\ X_2 \\ \cdots \\ X_N \end{bmatrix} \quad \text{where} \quad \mathbf{G} = a \begin{bmatrix} Q_{11}, Q_{12}, \cdots, Q_{1N} \\ Q_{21}, Q_{22}, \cdots, Q_{2N} \\ \cdots \\ Q_{N1}, Q_{N2}, \cdots, Q_{NN} \end{bmatrix} \quad (32)$$

28. A mobile terminal device, having N speakers contained in a case, in which

a speaker emission signal Si emitted from i-th speaker is given by Equation 33, by means of a matrix H including a transfer characteristic Hij through which a driving signal Sdi for driving the i-th speaker is transformed by at least inner-case acoustic coupling and emitted from j-th speaker, and a transfer characteristic Hii through which a driving signal Sdi for driving the i-th speaker is transformed by at least an amplifier characteristic or a speaker characteristic and emitted from the i-th speaker,

$$\begin{bmatrix} S_1 \\ S_2 \\ \cdots \\ S_N \end{bmatrix} = \mathbf{HSd} = \begin{bmatrix} H_{11}, H_{21}, \cdots, H_{N1} \\ H_{12}, H_{22}, \cdots, H_{N2} \\ \cdots \\ H_{1N}, H_{2N}, \cdots, H_{NN} \end{bmatrix} \begin{bmatrix} Sd_1 \\ Sd_2 \\ \cdots \\ Sd_N \end{bmatrix} \quad (33)$$

wherein the driving signal Sdi for the i-th speaker is created by processing an input signal Xi for the i-th speaker with a filter characteristic G, given by Equation 34, that is based on a cofactor Qij of an (i, j) component of the matrix H.

$$\begin{bmatrix} Sd_1 \\ Sd_2 \\ \cdots \\ Sd_N \end{bmatrix} = \mathbf{G} \begin{bmatrix} X_1 \\ X_2 \\ \cdots \\ X_N \end{bmatrix} \quad \text{where} \quad \mathbf{G} = a \begin{bmatrix} Q_{11}, Q_{12}, \cdots, Q_{1N} \\ Q_{21}, Q_{22}, \cdots, Q_{2N} \\ \cdots \\ Q_{N1}, Q_{N2}, \cdots, Q_{NN} \end{bmatrix} \quad (34)$$